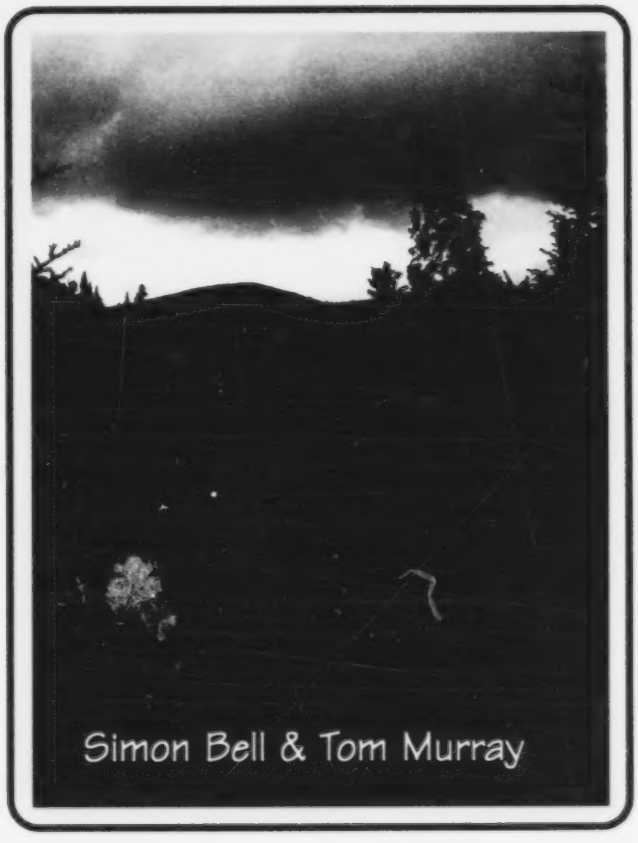
Forest Ecosystem Design:

Progress Report on

Development and Implementaion in the Maritimes



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FOREST ECOSYSTEM DESIGN: PROGRESS REPORT ON DEVELOPMENT AND IMPLEMENTATION IN THE MARITIMES

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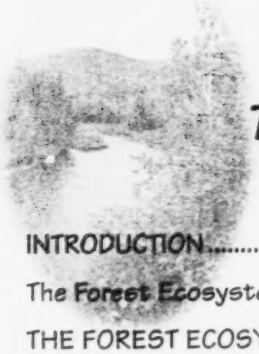
SUMMARY

Forest management is evolving faster than ever before. Informed environmentalists are now forest managers who constantly change the face of forest management as new science and techniques emerge. Forest Ecosystem Design is one of those techniques that has provided managers with a practical way to include aesthetics, ecology, and input from all forest users into a landscape-level forest management plan. This report reviews the progress of four landscape planning projects in the Maritime provinces. It describes the process, the locations, and the reaction of the collaborators to this all-encompassing, landscape-level approach, as well as recommendations for future work.

RÉSUMÉ

La gestion des forêts évolue plus rapidement que jamais. Les environnementalistes éclairés sont maintenant des gestionnaires forestiers qui changent constamment la réalité de la gestion forestière à mesure que de nouvelles techniques scientifiques et autres voient le jour. L'aménagement des écosystèmes forestiers est l'une de ces techniques qui permettent aux gestionnaires d'inclure de façon pratique l'esthétique et l'écologie dans un plan de gestion forestière considérant l'ensemble du paysage auquel contribuent tous ceux qui exploitent les forêts. Le présent rapport traite de l'évolution de quatre projets de planification du paysage dans les provinces Maritimes. Il décrit le processus, les emplacements et la réaction des collaborateurs à cette approche qui considére l'ensemble du paysage, et donne aussi des recommandations quant aux activités futures.



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INTRODUCTION

This report reviews the progress of four forest landscape planning projects in the Maritime provinces. These forest ecosystem designs cover over 20 000 hectares, and comprise a number of site- or stand-level cutblock designs that follow visual and ecological design principles. These projects were undertaken as collaborative ventures between private industry [Repap New Brunswick Inc., StoraEnso, Smurfit Stone (Canada Inc.), J.D. Irving, Ltd., and Fraser Papers Inc.], the Canadian Forest Service - Atlantic Forestry Centre, the Maritime Forest Ranger School, the New Brunswick Department of Natural Resources and Energy (NBDNRE), and the Nova Scotia Department of Natural Resources.

The four landscape-level projects were planned and designed from 1994–1997 and have subsequently been partially implemented (as these are long-term plans, it will be some years before they are completed). The aims of each project were basically the same: 1) to test the application of forest landscape-level, ecosystem-based planning and design, 2) to involve a number of stakeholder groups, and 3) to produce timber from areas that were, to varying extents, environmentally sensitive. These projects are, in chronological order, Malcolm Brook (N.B.), Sutherland Brook (N.S.), Popple Depot (N.B.), and Waters Brook (N.B.). The first two were pilot projects funded, for the most part, by the respective federal-provincial Forestry Development Agreements in place at the time. The two subsequent projects were initiated and funded predominantly by industry.

The cutblock designs, following visual and ecological design principles, reviewed here have been adopted as standard practice by J.D. Irving, Ltd. and have been applied on the Black Brook management area, certified in 1998 by the Forest Stewardship Council as being sustainably managed.

All these projects followed principles and practices introduced to the Maritime provinces in 1994 by the Canadian Forest Service (CFS) and the Maritime Forest Ranger School (MFRS) and which have been taught in courses presented by the MFRS since 1994.

The expertise behind forest landscape-level, ecosystem-based design was introduced and adapted from British and American practice by Simon Bell, until recently the Chief Landscape Architect of the British Forestry Commission. Forest landscape design was developed in Britain from the 1960s to the present, eventually becoming the main way in which state-owned forests are planned. In the beginning, this practice was mainly concerned with the visual effects of afforestation and logging; it then developed to encompass a completely integrated, multi-functional approach. Landscape-level forest ecosystem analysis and design were pioneered in the US Forest Service during the early 1990s by Nancy Diaz and Dean Apostol, in part incorporating British practice. In 1993, the Ministry of Forests in British Columbia asked Simon Bell to develop a manual of forest landscape design and a training module. One of the significant outcomes was the pilot forest ecosystem design at the West Arm Demonstration Forest near Nelson, BC. This subsequently led to a large number of such projects in British Columbia. The critical element of involving stakeholders in the design plans in New Brunswick was developed during the first pilot project by CFS and Repap New Brunswick Inc. These techniques were employed in all the subsequent projects with little variation and were successful, for the most part, because of Repap's willingness and ability to work with the public over many years.

In 1993, following some market research into future training requirements at the MFRS, Robert Whitney, the Director of Continuing Education, evaluated a forest design course held by the British Forestry Commission in Scotland, presented to an audience of foresters by Simon Bell. He felt that the course structure and content and the means of presentation would provide an ideal basis for similar training in Canada. He asked Simon Bell to develop a training course and accompanying design manual to suit the conditions, ecology, forest types, policy, and practices of Atlantic Canada. The first course was piloted in the fall of 1994 and has since been presented many times, at the MFRS and also in other Canadian provinces and in various American States. To date, a total of 277 people have received training:

1. Courses held at MFRS as part of the regular training calendar

Federal government	8
Provincial government	23
Industry	46
Other agencies	8
MFRS staff	6
Self-employed	3

2. Courses put on for mixed audiences in other provinces

Nova Scotia	18
Newfoundland	25

3. Courses run specifically for industry in Canada

J.D. Irving, Ltd.	22
StoraEnso	19

4. Courses run for US companies

Mead Corporation	34
International Paper	32
S.D. Warren	28

Tom Murray of the Canadian Forest Service also attended the course in Scotland and soon after decided to implement some of what he had learnt and test it in the Maritime provinces. He approached four companies in the Maritimes with a presentation developed from the course and, as a result, the two pilot projects, Malcolm Brook and Sutherland Brook, were initiated and subsequently implemented.

Pilot projects are extremely important components of any new development of forest practice. Whenever new theories and practices are introduced, it is important that forest managers and other interested parties are able to evaluate the processes, techniques, costs, and benefits before proceeding any further. With some forestry practices, such as the introduction of new harvesting technology, such an evaluation can be relatively short and results and recommendations can be available quite quickly. Forest planning, especially when it concerns non-timber values, forest ecology, and stakeholder participation, and where some time may elapse before the results become apparent, takes somewhat longer to test. There is also the risk that the immediate appeal of new ideas will wear off before the value of the ideas can be fully realized. This report presents some tangible results from the pilot projects and may spur confidence in the practice of forest ecosystem design so that it is taken up and applied more widely.

The report follows site visits to three of the four pilot areas and to the Black Brook unit during May 1999 by Simon Bell and Tom Murray. Ground and aerial photos were taken of the activities that had been completed. Forest managers were interviewed and feedback obtained from a number of the stakeholders originally involved.

The Forest Ecosystem Design Pilot Projects

Each of the pilot projects followed a similar process, although the method of preparing them varied to some extent. Each has similar features and contexts. Following a general overview of the process, a summary of each project will be presented.

THE FOREST ECOSYSTEM DESIGN PROCESS

Each pilot project followed a series of steps that have been proven, from the development of the technique, to work efficiently. These are as follows:

1. Set objectives for the design area
2. Collect inventory information
3. Analysis of the information
4. Development of an overall concept
5. Cutblock design
6. Evaluation, documentation, and approval
7. Implementation on the ground
8. Review and modification

Set Objectives

In each project, objectives for the future landscape were developed by a group of stakeholders, facilitated by Tom Murray and Julie Singleton (Consultant). The stakeholders were invited to participate and were chosen to represent a wide range of forest values. They included company staff, provincial government staff, and non-government groups with recreation, wildlife, or economic interests in the area (the first three projects lay on Crown land, so many other stakeholders had legitimate interests besides the forestry company who holds the license to cut timber). The fourth project, Waters Brook, is partly on Crown land, with the majority of the land base being held privately. However, the same stakeholder interests apply.

A standard approach was used to generate objectives: first, the stakeholder group was assembled and identified a number of values related to different resources. A general objective was derived for each value, followed by an attempt to specify the type of action or landscape condition that would indicate if that objective was being met. This is an open process, with no one stakeholder having a veto over values expressed by another. The whole aim of this exercise is to see how all values can be incorporated by planning the area.

The job of the facilitator is to guide the stakeholders, to prompt their discussions, and, if need be, to mediate in any disputes that may arise. The facilitator usually records the developing set of objectives on flip charts, which are then formally written up and circulated to all stakeholders for final comment, after which they are adopted as the official objectives for the project. It is interesting to note that each of the four individual stakeholder meetings produced almost identical lists of objectives. However, this should not be surprising, as the stakeholder groups have similar interests in each area. For example, a fisher in one area has similar objectives to a fisher in another area. Their interests are clean water, maintained or enhanced fish stocks, and a pleasant environment in which to conduct their fishing. These are universal objectives of stakeholders interested in fishing.

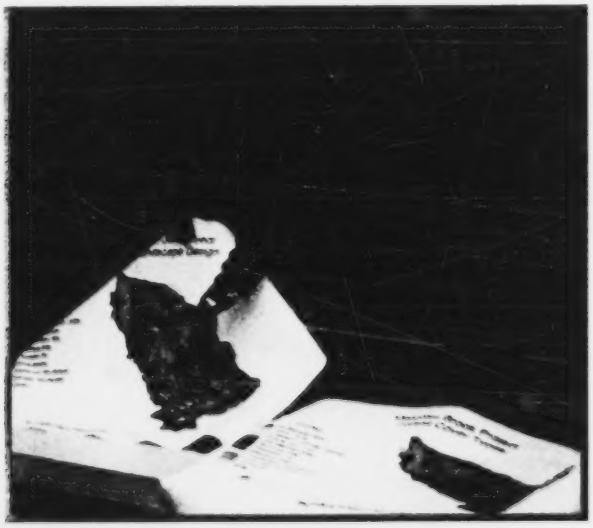
A subset of the stakeholder group or committee (which may number between 18 and 30 members) was chosen in three of the pilot projects to act as a design committee, participating more fully in the design process, and acting as a bridge between the main committee and the technical development of the plan.

Inventory

For each project, a set of inventory information was assembled. One of the problems of any such project is that information is sparse for some factors and much fuller for others. A unique strength of this process is that, although it is rare for special surveys to be carried out, many of the stakeholders possess much local knowledge that can be incorporated and used to support more theoretical knowledge about the area. The following is a typical list of information needed for landscape-level planning:

- Ecosystem types, forest cover, wildlife use, rare species, protected zones, natural disturbance regimes, old growth.
- Water quality and quantity, the hydrological system.
- Visibility, viewpoints, landscape character, special scenery.
- Harvest history, projected timber supplies, harvest systems, road locations, forest health and protection.
- Recreational use, trails, routes, locations for activities.
- Non-timber economic use, trapping, mushrooms and berries, commercial recreation.

The design committee and a project leader review the available information and ensure that it is all assembled, collated and, if possible, mapped to the same scale. Gaps are identified and strategies for overcoming any serious problems of missing information developed. These may include longer term surveys, the results of which will be incorporated in future revisions of the project.



Analysis

At this stage, the inventory information is analyzed in three distinct ways. This analysis can be undertaken by one or two people as a technical exercise and subsequently presented for review and comment to the design committee. Alternatively, it can be carried out as a group exercise by the design committee under the guidance of a skilled facilitator. Each method has advantages. The technical approach is cost effective and quicker, but it may omit elements of the analysis due to lack of local knowledge. The group approach ensures that everyone participates in the process and contributes their local knowledge. However, it is more time consuming and expensive.

The three analyses are:

Landscape character
Landscape ecology
Opportunities and constraints

Landscape Character Analysis aims to understand how the landscape is "put together"; it presents visual patterns. The reason for doing this is so that the layout of cutblock and retained areas is designed to fit into this character. This is particularly important in highly visible landscapes, but also proves useful in less visible areas, because part of what gives the area its character is also linked to the ecological patterns through the interaction of climate with the underlying landform. The two parts to landscape character analysis are landform analysis and landfeature analysis.

Landform analysis examines the three-dimensional shape of the underlying landform, such as ridges, valleys, convexities, and concavities. The technique uses the principle of natural, visual lines of force, expressed as arrows of different thicknesses running down ridges and up valleys, reflecting the flow of the eye when looking at a scene. This is used to design cutblock shapes, because, if they are designed to respond to landform with more flowing, organic shapes, they will reflect the natural pattern of forest stands and look less artificial.

Land-feature analysis examines the patterns overlying the landform, such as different forest types as well as man-made elements such as fields, roads, or existing cutblocks. Forest types frequently show a strong relationship to topography, for example, hardwoods on knolls and softwoods in hollows. The degree of variation in the pattern can be important for future cutblocks: complex variation on broken topography may lead to a finer-scale pattern of cutblocks than simpler patterns on simpler landforms.

Landscape Ecological Analysis seeks to discover the ecological functioning of the landscape. In this sense, the term landscape refers to a scale of analysis—bigger than a stand or site, smaller than a region. The analysis follows a sequence of steps:

1. *Landscape structure:* the component elements of the landscape are described, such as matrix, patches of different vegetation, corridors running across the landscape or pathways through it. This is mapped.

2. *Landscape flows:* water, animals, and people that live in the landscape and around it. These are identified and described. As well as special or rare species, common ones may tell a lot about the health of the ecosystem. The flows are mapped.

3. *Interaction between structures and flows:* different landscape elements are used by different flows in different ways; for example, in different parts of a habitat. The functioning of the ecosystem depends on the completeness of the structure for the different flows. A matrix or spreadsheet is often produced for this interaction.

4. *Linkages beyond the landscape:* some flows move in larger areas and migrate in and out. Problems elsewhere cannot be solved in the study area, although there may be key connections provided by the study area. These are described and mapped.

5. *Disturbance and succession:* here the dynamics of the ecosystem are examined. Disturbance by fire, insects, disease, or wind is an essential part of any ecosystem but is likely to occur in different ways in different parts of it. Succession follows disturbance as the ecosystem recovers and proceeds to develop towards "maturity." The types of disturbance and the rates of succession can be used to develop ecologically based harvest and silvicultural practices. A table is prepared for these.

6. *Desired future conditions:* the analysis suggests that at any time the landscape is likely to contain a pattern of certain elements distributed in certain ways and changing over time. This can be used to help formulate a concept for the managed forest that emulates, as far as possible, this natural character and thus ensures that, although managed to meet objectives, the landscape continues to function ecologically. A statement is prepared for this.

Opportunities and Constraints Analysis is used to determine the interaction of physical, practical, economic, social, and administrative factors on achieving the objectives. Constraints are those factors that may limit what can be done in certain places or at certain times, while opportunities are presented where there is most flexibility. Often a constraint on one objective (such as maintaining a riparian zone limiting harvest) may present an opportunity to achieve another objective (such as water quality, old growth, ecological connectivity, etc.). This analysis is mapped where the factors are physical elements on the ground, and a table is prepared defining the opportunities and constraints for each identified factor.

Development of an Overall Concept

This step is where the objectives and the analyses are brought together to see what emerges as a less likely pattern and structure for the landscape that will deliver the values for all resources indefinitely. The concept frequently contains two main elements: the harvestable portion of the landscape, described in terms of cutblock shape, size, silvicultural model, timescale and distribution; and the non-harvestable portion, often connected to form a network running through the forest. A common scenario is where the areas most likely to be catastrophically disturbed become the harvest units where silvicultural models aimed at emulating the character of that disturbance are applied, and those areas least likely to be disturbed, where longer-term continuity and old-growth conditions are likely to occur, are left undisturbed. An intermediate zone may include tolerant hardwood stands, the management and use of which may depend on company policy.

Cutblock

Cutblock design also includes the converse, a design of the non-harvestable areas. At this stage, the network of retained elements is designed to fit into the landscape, using the landform analysis. This avoids artificially geometric shapes, such as riparian corridors of a set width, in favor of more subtle areas reflecting local topographic and microclimatic conditions. Once that part of the design is complete, the harvestable area is subdivided on the basis of the landform and the forest stand types. These usually vary in size to reflect the scale of the landform, and use of organic, irregular shapes that interlock with one another. Each of these cutblocks must be evaluated for practical aspects such as access and the use of machinery. Specifications on the type of silviculture to be applied are developed and a time sequence for cutting is laid out that should distribute them across the landscape to avoid a progressive cutting pattern. Color-coded maps are produced for this stage.

Evaluation, Documentation, and Approval

Once a draft design has been completed, it is evaluated to see how well it meets the objectives. Calculation of volume produced over time, assessments of how well it is expected to function ecologically, the anticipated appearance, and its use for recreation are all aspects to be looked at by the design committee. If there are problems, the design is adjusted until everyone on the design committee is satisfied. Then the design is fully documented and the first cutblocks and road layout are submitted to the provincial government for approval.

Implementation on the Ground

This is carried out by road construction and harvest. The cutblocks have to be laid out, their boundaries following the design as closely as possible. Internal site-level design of elements such as wildlife tree patches, thinned edges, skid trails, and landings has to take place. Once harvested, the end result should be reviewed and if problems occurred that have a bearing on the design, modification should be made, with input from the stakeholders. As implementation proceeds, it is very worthwhile for the company to maintain dialogue with the stakeholders so that problems can be identified and solved without delay.

MALCOLM BROOK

The Malcolm Brook project area comprises a 4,080-ha tract of Crown land in Northumberland County, New Brunswick, bounded by the lower North Branch of the Little Southwest Miramichi River and the main Little Southwest Miramichi River, with Malcolm Brook flowing through the southern half of the area. These are important salmon rivers and the forest, because it is almost an island surrounded by them, has not been logged. It is a sensitive area with a virtually uncompromised forest landscape, and thus presented an ideal opportunity for forest ecosystem design.

The first step was to set up the project as a partnership between the company, Miramichi Pulp and Paper Inc. (Repap New Brunswick) based in Newcastle, the NBDNRE, the CFS, and other forest users. Funding was provided by the Canada/NB COOPERATION Agreement on Forest Development, and the three cooperating agencies.

Next, a scoping exercise was undertaken to assess the sources of data and collect as much as possible. Then, an objectives committee was established. Interests represented included timber, fishing, snowmobiling, and environmental concerns. Eighteen people attended the first meeting to develop the landscape objectives. The objectives emerged as a fusion of company objectives, provincial policies and regulations (on clean water, forest management, and habitat protection), and the objectives of other stakeholders. The facilitators (Tom Murray and Julie Singleton) synthesized the random expression of each person's objectives into a number of categories. Measures to address each objective were then devised. The final set of objectives was as follows:

Table 1. Landscape Objectives for Malcolm Brook

Resources	Objectives
Timber Resource	To maintain a sustainable timber supply while managing on an ecosystem and landscape level. • incorporate proposed cutting areas, from FORMAN model determinations, into resultant forest design plan wherever possible (older stands are harvested first). • ensure final harvest blocks are within Annual Allowable Cut (AAC) calculations. • ensure final harvest blocks are feasible
Old-Growth Resource	To maintain sufficient quality, quantity, types, and distribution of landscape and old-growth forest over time. • ensure quantity of old-growth forest, as identified by NBDNRE, is maintained in single blocks. • fit identified old-growth forest to landform without compromising integrity.
Forest Health	To maintain overall health of the forest to ensure proper ecosystem function.
Recreation	To protect and existing recreational potential of the area and provide more recreational uses as is appropriate for the ecosystem. • ensure present uses are preserved with no degradation. • ensure prime recreational settings (viewscapes) are maintained or improved in quality. • identify new compatible recreational uses, if any. • monitor or control access to limit public's activities.
Visual Landscape	To retain a high standard of visual integrity across the forest over the normal rotation. • ensure harvest blocks fit the natural landform. • respect adjacency guidelines to ensure temporal stability. • ensure reserve blocks fit the landform wherever possible. • ensure visual diversity is maintained/enhanced using principles of landscape design.
Water Resources	To maintain water quality. • follow all provincial regulations and obtain necessary permits for water course alterations. • maintain riparian buffers along watercourses (including bogs and wetlands), as established by NBDNRE (Clean Water Act).

Resources	Objectives
Fish & Wildlife Resources	To protect and maintain fish and wildlife resources as specified by the Provincial Wildlife Habitat Policy Goal. • maintain species diversity, a range of habitats in different successional stages, and corridors or links between areas. • identify and manage sites of unique or critical importance (mature coniferous habitat, deer-wintering areas, and riparian buffers for fish habitat protection).
Soil and Landform Resources	To maintain soil/site productivity and reduce site degradation. • minimize presence of roads and landings and other permanent features (take precautions to avoid erosion). • identify/specify operations for sensitive areas (include appropriate silvicultural systems).
Roads (logging systems)	To minimize the impact of roads while meeting engineering specifications. • ensure minimum density of roads. • ensure locations avoid sensitive areas and blend into the landscape. • ensure road access can be arranged to protect wildlife values.
Plant Resources	To maintain unique or sensitive plant communities, e.g., bogs and wetlands. • maintain appropriate buffers around sensitive sites.

One immediate beneficial result was that the committee members started feeling involved in the project and less apprehensive about what the company might be planning. A level of trust was established.

The landscape analysis followed the steps described above. Subsequent work was carried out primarily by Tom Murray and Julie Singleton, then presented to the design committee later. The landscape character shows an undulating topography comprising a number of large knolls separated by a number of distinct valleys that arose as part of the drainage system of the Miramichi River. The forest stands include softwood, mixedwood, and tolerant hardwood. There is a definite pattern where the largest hardwood stands are to be found on knolls while the valleys are dominated by softwood. This pattern became significant in the development of the design concept.

The landscape ecological analysis proved quite straightforward. Structures identified in the landscape were:

- Matrix: mature balsam fir and spruce—68% of the forest cover
- Patches: hardwood and cedar stands
  thinned areas
  a small lake
  wetlands
  a deer-wintering area
- Corridors: riparian zones
  roads
  streams and rivers
  mature coniferous habitat
  deer-wintering areas

Riparian zones, mature coniferous habitat, and deer-wintering areas are not necessarily readily recognizable components of the landscape, but they are all predefined by the NBDNRE as necessary for habitat protection. It is important to distinguish between functional and legislated corridors because the latter may turn out not to be functional when examined on the ground.

Landscape flows selected to be indicative of landscape functioning were:

- Water
- White-tailed deer and moose
- Songbirds
- Bears
- People
- Salmon and trout
- Birds of prey
- Coyotes
- Martens, minks, and otters

These are typical—a mix of water (always a relevant flow), animals who use the forest widely and some of whom are at the top of the food chain (thus indicating by their continued presence that many of the species below them in the food chain are also surviving), and people.

The interactions between structures and flows confirmed the importance of the corridors identified above for ecosystem functioning for many of the animals. Structures not yet in the landscape, such as cutblocks and successional stages of the forest, will also provide habitat requirements, but none are critical for any species.

Natural disturbance at Malcolm Brook has historically included spruce budworm and fire, and wind may also play a role. Human disturbance by harvesting has occurred to the north, just inside the project area. It is interesting to compare the character of natural disturbance, where many legacies, patches of trees, snags, and coarse woody debris left after the disturbance event contribute to ecosystem functioning, while previous clearcut logging practices have not contained such material. The shape of the disturbed blocks, irregular and diffuse of edge, also contrast with the abrupt edge of geometric cutblocks. The periodicity of disturbance, 25–70 years for budworm and 100 years for fire, show the "natural" rotation length to be somewhat variable, but not too different from that of managed forests. Of note is the presence of long-lived stands of species such as black spruce, which has a low likelihood of burning and is not at risk from fire. Other pockets of similarly low risk include tolerant hardwoods.

Successional information was not fully worked out, but the developing stand structure following disturbance would be expected to proceed through several stages. Silvicultural management might tend to speed up these stages and to favor certain species so that stand composition might vary. As the scale of disturbance would be limited by stand structure, composition, and natural breaks, a natural forest would tend to be composed of different-sized patches at different successional stages. Phased harvest could be used to emulate this to a greater or lesser extent.

As part of the landscape analysis, the study area was fitted into the provincial ecological land classification. This is a good starting point to fit a design area into a wider context. This turned out to encompass the ecoprovince with highest latitude and elevations, and thus the severest climate and a tendency towards a northern forest type. The area falls into the uplands ecoregion characterized by rolling topography and elevations of 150–460 m. This is the lower elevation ecoregion within the ecoprovince and has a slightly milder and drier climate. Vegetation of softwoods in valleys and tolerant hardwoods on upper ridges, as found at Malcolm Brook is typical. The ecotype of Tetagouche-Miramichi reveals a transition zone in forest species between the balsam fir-dominated north and the spruce of the south.

Table 2. Opportunities and constraints analysis for Malcolm Brook

Resources	Opportunities for Development	Constraints on Development
Landscape/visuals	• Design not limited by previous harvests. • Users provide input on likes and dislikes. • Hills limit visual impact on recreational users.	• Public opposition to clearcutting. • Harvest unit layout may be more difficult and expensive.
Recreation	• Increased access for snowmobile clubs and hikers. • Proposed northern haul road location will minimize traffic through the area.	• Increased traffic access will decrease wilderness experience. • Increased access for poaching fish and game. • Increased human disturbance on wildlife.
Timber and roads	• Maintain current wood supply to mill. • Attempt alternative harvesting methods. • Softer harvest may calm public.	• Harvest limited by Mature Softwood Habitat (MSH), Deer-Wintering Areas (DWA) (34%), and public concerns that impact on wood supply. • Age classes and species present limit silviculture options in softwood stands. • Roads must be minimal in number (increased skidding distance) and access monitored. • Northern haul road location increases truck costs.
Fish and wildlife	• MSH will be maintained to provide habitat. • DWA will be maintained to protect deer. • Edge and early successional species will have increased habitat after harvest. • Helps preserve ecosystem integrity. • Provides corridors within the matrix.	• Harvesting will eliminate mature softwood and/or hardwood habitats required by some species.
Plants	• Early successional species will be favored.	• Late successional species will be eliminated in some areas.
Water	• None.	• River too shallow and rocky for canoeing. • Roads must be properly built to avoid sedimentation that could damage fish habitat.
Soils and landform	• None.	• Sandy soils are susceptible to erosion, so roads must be properly built.

The next stage was to develop the design concept. This proved difficult because it is easy to get mired in the wealth of relatively detailed information accumulated during the analysis.

The pattern of major corridors of ecological importance related to the river valleys, and the pattern of tolerant hardwoods on the ridges and the slopes in between, became the drivers for the concept. Riparian zones and deer-wintering areas were linked and designed to form a stable network of late-successional forest providing protection to water quality, nesting for birds, movement corridors, and deer-wintering habitat. The tolerant hardwoods are also stable and can be managed for long-term quality wood production while providing habitat for a number of birds that rely on hardwood stands. An area of mature softwood habitat is required for pine martens but can move with time. Thus an area set aside now could be included in the harvest at a later date once a replacement area has developed following harvest and regeneration (it is this element of dynamic design that can increase harvest to be netted from the forest, providing all successional stages are present in the landscape in sufficient amounts and in the right places). Finally, the intermediate areas are available for harvest, broken down into a number of units of varied size and shape. The pattern is generated by the landform and stand boundaries and appears quite different from the more or less standard-sized rectangular blocks typical in the province.

The cutblock design developed from the concept and continued by assigning different harvest periods to the blocks. At the same time, a road system was developed that enabled all the blocks to be easily accessed. A novel feature was to ensure that the road adopted a curving alignment sympathetic to the design rather than a series of straight lines. In fact, a curving line, although somewhat longer, can take advantage of topography and ensure that more blocks are directly accessed, thus reducing the need for some of the spur roads.

The next step was to evaluate the proposed design to see what the overall effect was on meeting the objectives. Although it was clear that the non-timber values were met by the designs, some detailed analysis was needed to check the timber flow production. The results were reassuring. In the first place, no extra areas had been placed out of production by the design, because the requirements for retention were already known. Thus, the overall volume barely changed (it went up slightly). What did change was the flow by period. However, given that the project area is a relatively modest contributor out of a large land holding, there is plenty of slack to allow such variations to occur. The main operational difference was that the average block size was half the original proposal, so that there are twice as many units. This did not seem to pose a problem for the company because period 1 blocks were scattered throughout the area and the total road length is required in the first 5 years anyway. This is what would be expected by following the lead of the scale of the landscape, which at Malcolm Brook is quite intimate. Fragmentation is avoided

due to the large proportion of connectivity and retained areas, as well as the ability to spread the cutting well across the landscape. In the ecoregion as a whole, the smaller cuts will be balanced by much larger ones (as is the case where large expanses of budworm salvage already exist).

The design was presented to the design committee and then to the objectives committee. A table was presented that listed measures taken to achieve the objectives through the design. This reinforced the positive results gained by the design process, where all values were in fact achieved. The company then planned the road layout in detail, obtained the relevant approvals, built the road and proceeded to harvest two of the first period blocks (the only two completed to date). The plan was explained to road construction crews and it is obvious from the construction done that these crews bought into the spirit of the plan. In a memo sent to the Vice-President of Woodlands (Repap), one of the experienced company foresters stated that, after seeing the road "all in all as good a job as I've seen since I worked with Repap" and "all involved in planning, layout, and construction of this road should be congratulated."

The results on the ground show that one of the blocks has been laid out virtually identically to the map with only one or two minor adjustments. The second block, already one of the smaller ones, has been subdivided into two even smaller ones due to the presence of a stand of tolerant hardwoods within the block boundary. This type of alteration on the ground is to be expected at times, because the design is based on the level of detail available at the time. Cruising to lay out blocks may find stand anomalies, terrain variations, and other factors that necessitate alteration. As long as this adjustment keeps within the spirit of the design and is not an expediency for convenience of management, there should be no problem.

Discussion with staff from Repap, especially the woods superintendent Gérard Robichaud, provided a useful insight into the implementation process. As far as layout of the stands was concerned, there was no problem for the technicians, apart from where the stand of tolerant hardwood had to be left. They followed the layout well, taking a little more time over it to ensure an accurate and careful layout. In order for the layout staff to do such an accurate job, Mr. Robichaud presented the plan to them so that they were aware of what had to be done and why. They looked on the layout as more of a challenge to do a good job than an imposition. The wood volumes came out almost as expected. The cost of this was different, a little higher, partly explained by their desire to do a good job. However, Mr. Robichaud advanced the opinion that possibly some of their previous blocks were too cheap because they did not take enough care. He thought that, in the long run, they could be reducing their overall costs because they do not have to go back every year to fix things up.

The approval for the blocks followed easily once the design was completed because the NBDNRE was part of the process and the plan was, in effect, a pre-approval. Mr. Robichaud does not foresee any problems in future with the year-by-year submission of blocks for approval.

The detailed implementation of the blocks has left little structure within them. Mr. Robichaud does not consider this to be a problem because of the small size of the harvested blocks, the scale of the landscape, and the presence of so much retained structure. The company has not yet reported back to the objectives committee, but now that the first cutblocks are complete, it would be a good opportunity to review progress.

The silviculture for the cutblocks comprises natural regeneration filled in as necessary (therefore, probably eventually mainly balsam fir) spaced at age 13–14, 30% removed at age 30, and a final cut at age 70. There will be no ground preparation or use of herbicides. Thus, the stand will develop some natural characterization and succession will be advanced by spacing and thinning.

Mr. Robichaud believes that this process is the right way for the future, especially with ISO 14000 and the certification which Repap is going for in 2000. He is keen on the participatory approach and impressed with the way stakeholders buy into it. The process forces everybody (not least the company) to sit down and join in. However, to continue this approach in future will require more staff to be trained. If this were accomplished, the company could take on leading the process themselves.

SUTHERLAND BROOK

This project was carried out differently than the others. A full week was spent by the design committee, working its way through the design process in an ordered, disciplined way. At the end of the week, the project was virtually complete and three design options were developed and evaluated before the final solution was chosen. The project comprises a 5,100-ha tract of Crown land under StoraEnso's license located in central Nova Scotia in the area of the St. Mary's River. The area has a complex pattern of many brooks, lakes, ponds, and wetlands lying in hollows, some of these forming the boundary to the area and all generally flowing north to south. The St Mary's River is one of the most valuable salmon and trout fishing rivers and the project area is important for a wide range of recreational activities, including hunting, snowmobiling, etc.

As with the Malcolm Brook project, this project was set up as a partnership between the company, Stora Forest Industries (now StoraEnso) based at Port Hawkesbury, the NS Department of Natural Resources, the CFS, and other forest users. It was funded under the Canada/NS COOPERATION Agreement for Forest Development and the three co-operating partners.

In advance of the 5-day participatory workshop, which was held in June 1995, Tom Murray and Julie Singleton, together with Gerry Peters (the local manager for Stora), set up the Objectives Committee and held the first meeting, which 23 people attended. The objectives for the project were developed in the same way as for Malcolm Brook and a smaller design committee was set up. Some of the members of the committee went to explore the project area to get a good feel for it. Derek Geldart of Stora was charged with the task of getting maps, orthophotos, and other materials together and, immediately prior to the workshop, Simon Bell and Gerry Peters flew over the area and photographed it so that slides could be used as visual reminders of the character of the area.

Table 3. Landscape Objectives for Sutherland Brook

Resources	Objectives
Timber Resource	To maintain a sustainable supply of timber while managing on an ecosystem and landscape level. ◆ balance the age class of existing forest. ◆ harvest maximum wood volume within the framework of project objectives. ◆ actively manage productive areas (by promoting and encouraging natural regeneration). ◆ enhance productivity and quality of selected tree species by silviculture. ◆ maintain special species, such as white pine or hardwood content.
Visual landscape	To retain a high standard of visual integrity across the forest over the normal rotation. ◆ protect aesthetic aspects of forests, especially horizons, riparian zones, and significant viewpoints. ◆ locate roads to enhance views of landscape.
Fish and Wildlife Resources	To protect and enhance fish and wildlife resources as specified by the province, provincial guidelines, and company agreements (as a minimum standard). ◆ maintain wildlife habitat as outlined in the Nova Scotia Wildlife Habitat Guidelines. ◆ minimize access to selected wildlife habitats to lessen disturbance to wildlife species. ◆ protect critical habitat for wildlife (includes plant or animal) species, especially rare species.
Old-Growth Resource	To maintain a proportion of old-growth forest over time and landscape. ◆ maintain 5% old growth forest.
Recreation	To protect the existing recreational potential of the area and provide more recreational uses if appropriate for the ecosystem. ◆ use selected areas to enhance ecotourism opportunities. ◆ enhance recreational opportunities, e.g., hiking trails, snowmobile trails. ◆ provide for segmented recreational opportunities to reduce conflicts between users. ◆ establish designated parking areas for safety and convenience. ◆ maintain recreational access for ATVs and snowmobiles (retain established trails and old roads during harvesting).

Resources	Objectives
Water Resources	To maintain water quality. ◆ ensure the water supply and quality are protected for the St. Mary's River system by maintaining feeder stream integrity ◆ maintain water quality in lakes
Forest Health	To maintain overall health of the forest to ensure ecosystem function. ◆ design stands with respect to fire protection ◆ maintain a well-developed system of corridors and riparian zones to connect habitat types ◆ maintain or enhance biodiversity with a diverse network of [illegible] and forest types throughout area ◆ create a variety of cut sizes, shapes, and tree species ◆ investigate disturbance history of the area and attempt to re-establish natural succession of ecosystems
Operational Recommendations after Design Completion	◆ maintain a high standard of housekeeping on logging operations ◆ develop a system to monitor and revise plans as new information is found ◆ enhance fish habitat on feeder streams ◆ develop an education program to teach recreationists to protect water quality ◆ provide legal access (e.g., lease) for snowmobilers to facilitate insurance coverage ◆ protect streams during harvest and road construction ◆ review current plans for roads, harvest areas, etc. to eliminate conflict with the design plan

A report was drafted at the workshop, as the process unfolded and materials accumulated, so that, at the end of the week, the maps and report formed the basis for the final plan and something very tangible was produced. One feature of this project is the way in which everyone on the design committee contributed to the design. All the maps are the work of many hands, each person contributing their knowledge. This degree of participation leads to an extremely high "buy-in ratio." It is also the case that much more local knowledge fleshes out the other available information to a very significant degree.

As before, scoping produced much inventory information and local knowledge filled in many gaps, although significant gaps still remained. However, not only did the design committee represent the stakeholders but many of them brought a range of professional expertise to the table in the areas of ecology and recreology, which added to the quality of the work.

Analysis produced some detailed outputs. The time available and the number of participants meant that each step was as fully developed as possible. Large-scale maps enabled fine detail to be noted.

The landscape character analysis revealed a complex area despite relatively simple, subtle topography. The landform divided the area into three sections: the northwest and southeast areas were flattest, with fewest features, and the central section comprised more undulating topography with many well-defined knolls. This was to have a strong influence on the design. The land feature analysis was heavily influenced by some existing cutblocks as well as by the numerous small water features that characterize the area.

The landscape ecological analysis revealed a much more diverse landscape structure than that of Malcolm Brook, as follows:

- Matrix: Black spruce
- Patches: White pine stands
  Balsam fir stands
  Red pine (plantation)
  Mixed wood
  Cutovers
  Planted cutovers
  Hardwoods on ridges
  Hardwoods on streams
  Borrow pit
  Barrens
  Lakes
  Open bogs
  Treed bogs
  Fens
  Ponds linked to streams
  Isolated ponds
  Beaver pond
  Graveyard
- Corridors: Roads
  Streams
  Riparian zones
  Snowmobile trail
  Road right of way
  Boundary strip to reserve

These were mapped and immediately a pattern began to emerge that showed the occurrence of many patches.

Landscape flows were chosen as for Malcolm Brook, the list being very similar:

- Water
- Deer/moose
- Song birds
- Black bear
- People
- Fish
- Raptors
- Furbearers
- Water fowl
- Wood turtles

In this project, the interactions between structures and flows were examined in greater detail. A spreadsheet was prepared where the columns represented the flows and the rows the structures. At each intersection, the interaction between each flow and each structure was described. From the completed spreadsheet, it was possible to see that some landscape elements were much more significant in their contribution to ecosystem functioning than others, such as the riparian forest, wetlands, etc. Links were also considered. One of the major ones was the water flowing into and out of the study area, and the movement of bears and moose from nearby barrens.

Disturbance and succession proved interesting. A table was drawn up to examine the scale, duration, frequency, and resulting structure of each type of disturbance. These were fire, insects, fungi, wind, sleet, snow, ice, fauna, porcupine, deer, beaver, moose, larch sawfly, clearcutting, and road construction. As can be seen, human disturbance, which has already had more effect than at Malcolm Brook, was specifically included so that the comparison of effect could be made.

Table 4. Natural disturbance in Sutherland Brook

Type	Scale	Duration	Frequency	Structure
Fire	Large, '000s ha Small, 1-100 ha	Months days/wks/mos	100 yrs	Scattered large old pine, wet and low-lying areas Some HWs left unburnt
Insects and fungi	Minor-individual Trees/small groups	yrs	continuous	Small holes
Wind	Patches in late successional spruce and fir May start and develop from insect/fungi-caused deaths	hrs	whenever strong gale	Patches open < 1 ha and keep enlarging—pine left standing
Sleet, snow, ice	individual trees in northern HWs	hrs	every winter	Individual trees fall over under weight of snow, etc.
Fauna, porcupines/deer	Patches, killing and debilitating fir, hemlock, fir-fray, browse and strip	over a winter	every winter	Patches of dead and dying standing trees
Beaver	±5-ha pond+ areas felled Related to water features; brooks, etc.	yrs	continuous	Aspen suckering plus flooded areas with standing dead wood
Moose	1-2 ha	over winter	annual	Affects structure of trees No mortality
Larch sawfly	All larches	several seasons	50-60 yrs high probability of imminent attack	Groups/patches of standing dead trees

Table 5. Human Disturbance in Sutherland Brook

Type	Scale	Duration	Frequency	Structure
Clearcutting	from 30–50 ha limit	months	89, 93, 94, 95	Islands, groups of trees—little coarse wood debris—slash left—hard edges
Roads	variable	permanent	permanent	Hard edges

Successional stages were worked out in greater detail than at Malcolm Brook for four different scenarios:

- post-fire black spruce
- post-fire spruce/intolerant hardwood/mixed wood
- clearcutting of black spruce
- small-scale disturbance within the fire cycle.

There are distinct constrasts between, for example, the post-fire black spruce, which proceeds through five successional stages to become old growth at age 250 years, and managed black spruce after clearcutting, which only proceeds to around 80 years before being ready for harvest. This highlights the differences between the natural and managed stands, although it is doubtful that much of the post-fire black spruce grows beyond 100 years because of the likelihood of repeated fire. Old-growth conditions tend to occur in places least likely to burn, such as riparian zones, which will be retained in any case. Thus, the apparent discrepancies may not be as great as they first seem.

The opportunities and constraints analysis, being done in a participatory way, yielded a great deal of information that was both recorded on a map and presented in a table. As well as analysis in relation to the resource values identified in the objectives, other factors were selected, such as ownership, logging techniques, land-use history, and the location of the area. What became clear was that the easy terrain and nature of the forest presented many opportunities to protect features of value and to incorporate quite complex harvesting methods to emulate the effect of natural disturbance that would be of great benefit to wildlife.

The design concept stage was particularly interesting in this project. Following some prompting by the facilitator, the first task was to identify all the critical, irreplaceable habitats and then to design a network linking them all together. This incorporated the riparian zones, corridors, deer-wintering areas, old growth, and all the water features. Also, the tolerant hardwood stands were added as a second element. This resulted in a complex pattern that served to subdivide the area into many large and small patches of operable forest. The next question was how to divide it into cutblocks. Here three options emerged. The first took the form of mimicking a large-scale disturbance by fire by cutting a small number of large areas which, when regenerated, would serve to produce significantly sized interior black spruce habitat. Some members of the group felt this was too bold and suggested a second option: that a larger number of smaller blocks would lessen the impact and increase community acceptance. The third idea was to follow the variation in landscape character, by including some larger scale blocks to the northeast and southwest, where topography was flatter and the landscape held few barriers to

the spread of a fire, and in the more diverse central portion, some smaller blocks would naturally fit. The group then divided into three parties who mapped out each option. These were presented to the whole group and the unanimous conclusion was that the third option, of mixed-sized blocks reflecting landscape character, was the best. It was then taken further with each block being assigned to a period.

One difference of the Sutherland Brook plan compared with the other pilot projects is that it only covers a period of 10 years, with part of it already cut. This means that the rate of change is much faster than in the others. However, such is the value of the forest ecosystems network provided by the critical habitats that this was considered not to present a problem.

The plan was then completed by the company. An analysis of timber volumes was made and an assessment of how the plan meets the objectives was carried out. The final plan was presented to the objectives committee in October 1995. The presentation concentrated on how it would meet the objectives. The committee members were very positive about the forest design and expressed appreciation at being included in the process; they felt it would more than meet their objectives, although some reservations about the larger cutblock sizes were expressed. The company then presented the plan to the Provincial Integrated Resource Management Committee for approval, which was granted.

Implementation involved setting out some complicated shapes and also carrying out some cutblock level of design to incorporate smaller scale features of stream zones, wildlife tree patches, etc. This had the effect of significantly reducing the visibility of the larger blocks from any given viewpoint, and provided a good deal of habitat within the blocks. In fact, so much material has been left on site that the blocks could even be said to appear scruffy, untidy, and badly finished. In fact, the scruffier they are, the more "natural" they are, so public perception of tidiness needs to be adjusted to accommodate the needs of emulating natural disturbance.

According to the planning forester, Derek Geldart, the company is now in the fifth year of implementation and the integrity of the plan remains intact, although a right of way for a gas pipeline has been put through part of the area. Between 1996 and 1998, 400 ha have been harvested, yielding 64 000 m^3 of softwood and 1000 m^3 of hardwood. One hundred and fifty hectares were scheduled to be cut in 1999 to yield 20 000 m^3. Natural regeneration on most stands has turned out to be inadequate, so in-fill planting is taking place.

Discussions with Gerry Peters of StoraEnso indicate that implementation of the plan was very smooth. Progress updates (written notes attached to a letter) have been circulated to the Objectives Committee on two occasions, but there have been no particular issues of concern. Wood production is meeting the company's requirements so far, although there may be some overall loss if they decide to give up the volume (40%) available from riparian areas (as they are allowed to cut by the province). The process allowed the company to cut larger areas than permitted by the provincial wildlife guidelines, yet this was actually better for wildlife, due to the type of harvest. This shows that, when properly planned, timber harvest and ecosystem management need not be in conflict.

Annual approvals for each year's cutting are achieved very quickly, which cuts down on the administrative costs to both the company and the Department of Natural Resources and Energy. There are no extra layout costs involved; in fact, it may be cheaper overall because there is less cruising and search for likely cutblocks, as the plan tells them where to go. Harvest costs are either the same or a little lower due to the bigger cut size and not spending time cutting "rubbish" which is now left as legacy material. The cuts seem smaller than they actually are, because of the irregular shape and the internal retained clumps, etc.

The company does not use herbicide for silviculture and, in places where there is a strong hardwood component, they try to retain 60% canopy closure to cut down on the coppice and weed growth. There is no ground preparation, so no disturbance of the legacies and brush. These cuts look untidy but have lots of habitat left. Much of the overstorey is white birch which will eventually die out and provide dead wood habitat.

So far, the company has not produced another plan of this type, but staff have incorporated what they learned into the way the company operates. Experience gained using this plan has given them confidence to work on other sensitive areas.

One of the points made by several people is that the week of intensive work is too costly and time consuming, so less expensive ways must be developed if the FED approach is to be used more widely.

POPPLE DEPOT

The third project was prepared in a way similar to Malcolm Brook, with the majority of the work carried out by Tom Murray and Julie Singleton, following initial discussions and scoping with the stakeholders. The project area covers 7,015 ha of land in Northumberland County, NB, just east of Mount Carleton Provincial Park. It is divided into two sections by the Nepisiguit River. The land is Crown land under licence to Repap New Brunswick Inc. and Stone Container (Canada) Inc. The area north of the river is licensed to Stone, the southern portion to Repap. Popple Depot lies in the middle of the area and was a traditional meeting place for Micmac Indian families. Today, it is a popular recreational spot. The Nepisiguit River is extremely important. Compared with the topography of Malcolm Brook and Sutherland Brook, the terrain is steep, highly visible, and views can be obtained over the area from various lookouts. Thus, the visual sensitivity is much greater. The northern location, high elevations, and cool climate have led to the area being dominated by conifers.

The project was developed as a partnership between the two companies, the CFS, NBDNRE, and other forest users, funding being provided by Repap while other partners provided contributions in kind. An objectives committee, known as the Popple Depot Advisory Committee, was established as in the other projects and the table of objectives was developed through a meeting facilitated by Tom Murray and Julie Singleton.

Table 6. Ecosystem objectives for Popple Depot (developed at meeting in Bathurst on September 12, 1995)

Resources	Objectives
Visual Landscape	To maintain a high standard of visual aesthetics across the Popple Depot ecosystem over time and enhance the ability to see selected viewscapes: ◆ particularly during all phases of harvesting operations and any other human disturbances, i.e., road location and design, harvest unit shapes, choice of logging system, and location of recreational trails, etc. ◆ attention to the special area, Corker's Gulch, by creating a safe, advantageous viewing area.
Recreation Opportunities	To protect and enhance the existing and future recreational potential of the defined area, while maintaining overall ecosystem health: ◆ provide for segmented recreational opportunities to reduce conflicts between users. ◆ recognize and protect the considerable recreational opportunities in the area such as canoeing, hiking, mountain biking, mountain top hiking, white-water rafting, fishing, hunting, bird watching, snowmobiling, cross-country skiing, snowshoeing, ATVing, camping (temporary campsites and permanent camps), nature photography, and art. ◆ maintain access ibility to selected areas wherever feasible.
Wood Supply	To maintain a sustainable supply of timber while managing on an ecosystem and landscape level: ◆ harvest maximum wood volume appropriate for the ecosystem. ◆ incorporate proposed cutting areas from FORMAN model determinations into ecosystem design plan wherever possible. ◆ ensure harvesting shapes are feasible. ◆ ensure harvested wood volume is within annual allowable cut (AAC) to guarantee timber sustainability. ◆ enhance productivity and quality of tree species by use of sound silvicultural prescriptions, avoiding herbicide use where alternatives allow. ◆ stand-level prescriptions include selective harvesting where stand characteristics allow.
Heritage Values	To protect heritage values identified in area: ◆ to protect area identified as First Nations traditional trail as a historical hiking/interpretive trail.
Old-Growth Resource	To maintain appropriate portion of old-growth forest over time in the defined ecosystem: ◆ ensure quantity of old growth (MCFH), as defined by NBDNRE, is maintained in single blocks. ◆ fit old-growth forest to landscape without compromising ecological integrity.

Resources	Objectives
Ecosystem Health	To maintain overall health of ecosystem to ensure proper ecosystem function and sustainability while recognizing recreational opportunities: ◆ maintain system of corridors and appropriate riparian zones to connect habitat types and protect water quality. ◆ maintain appropriate level of biodiversity for ecosystem, e.g., old growth, rare species such as Bicknell's Thrush, orchids, etc. ◆ maintain relative proportions and species contents of ecological elements.
Fish and Wildlife Resource	To protect and enhance fish and wildlife resources as specified by provincial guidelines: ◆ identify and protect critical habitat (flora and fauna, including furbearers). ◆ maintain appropriate species diversity, range of habitats in different successional stages, and corridors between areas. ◆ minimize roads into critical habitats.
Other Industrial Resources	Attempt to reconcile mineral exploration and mining potential with other values in ecosystem.

Scoping and inventory took place in the same way as for the other projects.

Landscape character analysis concentrated more on the topography because of its more dominating nature. A distinct pattern can be seen from the map showing the visual forces, with the major and minor valleys dividing the slopes into several well-defined, rounded summits and knolls. This is a landform of simple slopes, flowing skylines, and few subtleties on the slopes themselves. The land-feature analysis shows that the landscape, although ecologically within a softwood ecotype, actually contains much hardwood, especially intolerant hardwoods, on many of the slopes as a result of fire and past logging. This makes the landscape very attractive, especially in the fall. White pine is also a feature of the landscape. An unusual part of the land-feature analysis was to consider the role or purpose of different elements in the landscape. This could be used to help identify what elements should be retained or managed for over time. Negative features were also identified so that they could be eliminated.

Table 7. Points of consideration for Popple Depot land-feature analysis

Feature	Purpose Served
Hardwood	• fall color • visual interest • ecological diversity • alternative harvesting options
Riparian Zones	• wildlife travel • water protection • water courses complicate harvest • loss of timber • wide buffers • camp/picnic areas • variable forest species along riparian zones, e.g., softwoods, hardwoods • water quality • movement corridors for animals • wetland plants
Cutovers	• early successional habitat • new species • future food • geometric harvest lines
Roads	• access for recreation • snowmobiling • fishing/hunting • skiing • birding • harvesting forest products
Deer-Wintering Areas	• Riparian zone needs more visual variation to remove straight boundaries. • critical wildlife habitat
White pine	• special management • visual diversity • ecological diversity
Corker's Gulch	• excellent viewscape • unique area
Rivers/streams	• river systems quarter the study area • numerous small streams flow into them • well-defined valleys • fishing opportunities
Road systems/forest roads	• main roads divide area into thirds • old roads follow water courses • numerous old roads—impassable except on foot

The landscape ecological analysis followed the established method. The landscape-structure map resembles the land-feature map because of the large number of patches of different forest types in the area which are also visually different. The structures are as follows:

- **Matrix** **Black spruce/balsam fir (rather fragmented and not large in extent)**
- **Patches** **White pine**
  Tolerant hardwoods
  Jack pine
  Cedar
  Intolerant hardwood
  Cutovers
  Planted cutovers
  Lake
  Wetlands
  Camp area
  Airstrip
  Inoperable areas of old growth
  Burnt area
- **Corridors Roads**
  Streams and river
  Riparian forest
  Snowmobile trail
  Hiking trail

The flows were selected on the same basis as before:

- Water
- Deer
- Songbirds
- Black bears
- People
- Raptors
- Fur bearers
- Wood turtles
- Bicknell's thrush
- Eagles/osprey
- Rock vole
- Gospie's shrew
- Sweetgrass
- Broad lipped tway blade

Some of these are rare in the area and need careful management. The patterns of movement were mapped. The interactions between structures and flows were noted on the table of the flows, but not carried out in greater detail.

Disturbance regimes were given special emphasis and, in the tables prepared, succession after each type of disturbance was added in another column, although the successional stages were not so developed. A contrast between natural and human disturbances was made. This showed that the managed forest rotation length lies well within the range of natural disturbance, none of the forest areas generally reaching more than 100 years of age naturally because of the prevalence of fire and budworm, except in the moister, sheltered areas. The major difference is the resulting structure, although modern harvesting methods already leave more slash behind than previously, which makes the cutblocks closer to natural disturbance in their character (although not their shape).

Towards the end of the analysis, the influences of disturbance and succession were examined to help provide ideas of how the landscape could be modified, such as by varying the cutblock size to reflect the natural variation more closely, to use more selection harvest, to carry out controlled burning or to minimize management in some places to let nature "carry on." These are examples of the kind of ideas that can be generated from a deep analysis as opposed to the application of broad rules. Not all the ideas may be practical to implement or socially acceptable. This analysis leads towards the desired future condition. Some of the ideas generated by this project include: reducing the balsam fir component so as to avoid budworm epidemics to some degree, increasing the white pine, red pine, black spruce, and tolerant hardwood content of the landscape so as to spread risk and increase diversity. Also, increasing the cedar content in the deer-wintering areas could be useful as it would provide more winter browse.

Next, the opportunities and constraints were analyzed and, as before, developed in relation to resource values and other factors. From the list, it is clear that there are many more opportunities than constraints in the area. This is good for all objectives except timber supply, because the main constraint is a reduction in wood availability due to the need to protect many areas. However, these protected areas were not derived from the plan but were already in place.

As before, a map had already been produced, which showed many areas where timber production was effectively prevented. These provided the framework for the design concept. The design concept is based around the values associated with the Nepisiguit River valley bottom and its major tributaries, because this encompasses the most valuable habitats, most of the recreation, and the greatest chance to develop old growth. The other element of forest retained in the concept is the inoperable land on the steepest slopes. Areas of mature coniferous forest habitat, riparian zones, deer-wintering areas, a unique area known as Corker's Gulch, a recreation area, and the cultural zone around Popple Depot are amalgamated to

form an extensive reserve taking up almost all of the southern half of the project area. The northern half becomes the area where timber production is concentrated. It was divided into a series of organically shaped blocks through which run riparian zones associated with the Nepisiguit tributaries. Some blocks were designed for part of the mature coniferous forest habitat because it needs to be managed to maintain its qualities.

The design was then evaluated. A chart showing how the landscape flows are to be accommodated helped demonstrate that the plan maintains ecosystem functioning, while another chart showed how each objective was to be addressed in the plan. This was presented to the Advisory Committee. No analysis of wood production was carried out on this project as it was deemed unnecessary for the relatively small area involved. The plan produced quite a different result from the other pilot projects because of the large amount of protected area. However, it shows the value of such an approach in helping to develop a management plan even where no large-scale cutting is to take place.

Not much activity has taken place since approval was granted. However, over the next few years, the companies will start to implement the plan. The companies and NBDNRE have kept the Advisory Committee informed of progress and took them on a field visit a year after the plan was approved. Ian Pryor, one of the planners from Repap, said that if Forest Ecosystem Design is to be taken further there needs to be some technology transfer from the experts—the planners need some training on the process and methods. Analysis techniques to emulate plan outcomes are also needed, computerized if possible, to decrease reliance on manual methods.

At an evening meeting attended by a number of the stakeholders, there was some impatience to see more activity taking place in the project area and to see the process applied elsewhere beyond the pilot project. One stakeholder said it was very good to see other values taken into account—at one time, only timber was considered. Several of the stakeholders said that their trust in the companies has increased to a positive level. They truly appreciated the chance to participate, whereas before they would have been ignored or unable to express their concerns; they did not expect to be listened to even if they did get access to express their concerns. Dave Prebble, the recently appointed Woodlands Manager for Repap said that companies need to change. The impetus to gain certification leads towards more public participation.

WATERS BROOK

The fourth project was prepared in a similar way to Malcolm Brook and Popple Depot. Tom Murray and Julie Singleton, again hired as a consultant, carried out the majority of the work. There were several initial meetings with Fraser Papers Woodlands staff to explain the process and establish the responsibilities of each participant group and the project deliverables. An established committee, called the Tobique River Advisory Committee, was used as the stakeholder committee for the project. This Committee had been in place to advise the Company on stakeholder concerns for several years.

The area selected for the project is an area adjacent to the Mamozekel River, including the Waters Brook and part of the Everett Brook Watershed. The southeast boundary is the main road to Mount Carleton Provincial Park which is the largest and remotest camping and hiking park in New Brunswick. It was primarily because of the view of the project area from this road that it was chosen. The project area was predominantly private freehold land with a small portion of Crown land included. This presented a unique challenge to the designers because of the different management guidelines between the two tenures. The boundary between the two was a dominant visual straight line boundary in the forest.

It is a 5,300-ha area where typically, tolerant hardwood stands cover the well-drained ridges and grade into mixedwood stands on upper ridges. The middle and lower slopes have some tolerant hardwood but consist mainly of spruce, yellow birch, and fir mixes. Cedar, mixed with balsam fir and black spruce is typical on the flats of valley bottoms adjacent to the streams.

The objectives were set at a meeting held at a local hunting and fishing club arranged by the Company. On the same day, the Company flew the members of the Committee over the area to provide them with a better overall picture of the area. The objectives were again very similar to those of the previous three projects. These objectives fit very well with the landowners' objectives, which provided some comfort to the Company.

1. To protect the forest ecosystem, maintaining a healthy forest with appropriate forest diversity for the Sisson Reservoir ecodistrict encompassing the Waters Brook Project area.

2. To protect wildlife resources by identifying and maintaining critical habitat; and with appropriate spatial planning provide travel corridors and a range of habitats in different successional stages.

3. To protect aquatic habitat by maintaining riparian zones and controlling sources of soil erosion to maintain water quality.

4. To employ the best road-building and roadside harvesting practices to satisfy aesthetics requirements.

5. To maximize wood production and fiber utilization using current, operational methods and equipment while maintaining a reasonable harmony with other forest users, such as hunters, fishers, trappers, and bird-watchers.

6 To recognize and identify education and research needs or opportunities.

7. To encourage public input through the advisory committee to follow up on the project and to improve general forest practices in the future.

8. To ascertain the economic feasibility of the forest ecosystem design process using the Waters Brook project.

The project proceeded like the others, with a great deal of work accomplished by Fraser Papers and the Tobique River Advisory Committee. The committee was focused, which led Company representatives to remark that they had worked better together on this project than ever before. The project was presented by the designers on September 4, 1997. The report was received very well in its entirety by the Tobique River Advisory Committee. The Company reserved a decision and told the Committee they wanted time to review it, mainly to test what effect it would have on the AAC. Unfortunately, the Company's final response to the proposal was not enthusiastic. No wood supply analysis was ever presented and the project was essentially dropped.

CUTBLOCK DESIGN AT J.D. IRVING, LTD.

The final part of this evaluation describes a scale to examine the detailed layout of cutblocks that has become an established feature of operation at the Blackbrook management unit. This practice was initially put in place after Gaétan Pelletier, the District Superintendant, attended a forest landscape design course at the MFRS. He redesigned planned, rectangular cutblocks to create more irregular shapes, incorporating patches and clumps left for wildlife purposes, which also serve to break up the view. The company also commissioned a tailored forest landscape design course which included a field visit where some of these early attempts were evaluated and discussed. Staff gained valuable experience in laying out blocks from this course and are now producing some excellent results. This design element helped J.D. Irving, Ltd. attain certification from both the Forestry Stewardship Council (FSC) and under ISO 14001. The company has since developed a statement or guide to best-management practice in relation to forestry and aesthetics. This is provided to all contractors. It is posted in the cab of the harvesting machines, so that the harvesters know how to interpret the layout and look for opportunities, such as retaining a big crowned tree, etc., that may have been missed by the cruisers. As part of the drive to raise standards, the company held a meeting where aerial photographs of completed cutblocks were shown, each with the responsible foreman's name on it. This provides good feedback and fosters pride in the job, together with some competition. Practical experience has enabled the staff to select cutblock edges to stand for 20 years.

Out in the field, the appearance of the cutblocks is very impressive. One of the foremen, Raymond Michaud, said that it is his aim to design the cutblocks in such a way that he cannot see the full extent of the block from any point on the forest road. He said that a designer needs to be able to read the forest and landform to be able to find the edges in the woods, building up experience. The key is to be able to select patches that are big and stable enough not to blow over. Thinning and feathering of edges is economical to do by picking softwoods out of mixed stands; such trees are likely to blow over anyway.

Following harvest, the silvicultural treatment is more intensive than that observed at Malcolm Brook or Sutherland Brook. The sites are crushed to flatten slash and debris. This gives a much cleaner appearance which emphasizes the patches, clumps, and individual trees left on site. The sites are planted and herbicide treatment is used to suppress weed competition. This can be done without harming the retained patches with modern helicopter-borne techniques.

The staff were very open to learning from their work how to make improvements. Extra boldness of shape, more feathering of edges, and an attempt not to use the straight roads as block boundaries are some improvements that could be made.

As part of the most recent management plan, Gaétan Pelletier has divided the management area into four zones of visual sensitivity. The most sensitive areas will be designed as whole landscapes, while the rest will continue as block-by-block design. The first landscape design has been completed for the Glazier Lake area.

DISCUSSION

From the feedback obtained from the recent visits, it is apparent that the pilot projects have been successful, although implementation is not as far advanced at Popple Depot. All the participants continue to express their satisfaction with both the process and the results. There have been no problems with implementation, costs have not been excessive, wood supply has met expectations, and approvals have been speedy. The results on the ground, both in the FLD pilots and the cutblock designs, have met or exceeded expectations in terms of quality.

The question arises: if the process delivers such benefits why has it not been taken up more widely? Clearly the picture is a mixed one. StoraEnso have absorbed much of the practice into their day-to-day management without necessarily following the complete process. J.D. Irving, Ltd. have started to move from block design to landscape design on sensitive areas.

Several answers to the question are possible:

1. The pilot projects were developed with a heavy involvement of staff, outside experts, external funding (except in the case of Popple Depot) and quite intensive sessions. This appears to be a lot of work for relatively small portions of most companies' operating areas. The way the projects were managed thus masks to some extent the efficacy of the process.

2. The recent emphasis on obtaining certification has diverted effort and attracted more attention. However, certification requires that public participation and ecological planning, as well as all the other values, are taken into account during planning. Perhaps once the dust settles on certification the the benefits of FLD as described here will become apparent.

3. The level of skill required may put people off, especially the senior decision makers. Considering that large numbers of people have attended courses, it is surprising that this is a problem. However, being expected to lead a design after 3.5 days training is a tall order, and the number of staff trained in different companies varies. Those with most confidence in applying design (StoraEnso and J.D. Irving, Ltd.) also happen to be the companies with the most staff trained. This builds up a general level of knowledge and allows staff to discuss projects and ask for feedback. It also makes it easier to implement design if staff at different levels have received some training.

4. A perception that up-front costs are too much. It is difficult to demonstrate that this need not be the case and that expenditures at the beginning are offset by savings later on. For example, although the Sutherland Brook project cost quite a lot to produce, savings in subsequent approvals have been made. Economies of scale apply to design: the development of a plan for a large area may only cost a little more than that for a small area, and the three projects were by no means large. In fact, bigger areas are better, because the ecology is easier to understand in a wider context and timber harvest scheduling makes more sense over larger areas. One or two projects in the 10,000–40,000-ha size have been carried out elsewhere at a very similar cost.

5. Unwillingness to change practices, that inertia which is a feature of human nature, may also have an effect. There is enough change as it is, so more just makes matters worse. However, as all the changes in forestry are leading towards the need for landscape-level planning of some kind in association with public participation, this inertia must be overcome. At the very least, the FLD process, having been tested in these pilot projects, has reached a certain comfort level with foresters, so that using a method developed to be practical is better than waiting for something to be imposed from outside.

CONCLUSIONS AND RECOMMENDATIONS

There are clearly enormous benefits from FLD:

1. Long-term planning based on the character of the land and the ecosystem is necessary for ensuring sustainable management from an ecological point of view.

2. The participatory approach, whether using an objective committee or the more active, hands-on variety, is necessary for certification and also to meet sustainable management from a social point of view.

3. The long-term planning, where economics and wood-supply forecasts are built in together with constraints and opportunities, ensures that the plan is feasible and also enables sustainable management from an economic point of view.

Thus, the threefold requirements of sustainable forest management are attained by the development and implementation of a forest ecosystem design.

This review has revealed the success of the FLD approach at the landscape level and of cutblock design at the site level when it is carried out thoroughly and implemented properly. In that respect, the results are gratifying. What is disappointing is that there are not more projects underway. This is probably due to some of the reasons listed above, so that some concrete recommendations are needed to carry out more design.

The following recommendations are made:

1. Training in the process of FLD (as opposed to the principles behind it which are already covered) should be offered by the MFRS. This would bring up the skill level to allow company staff to invite objectives committees to take part, to use the information and skills available in other agencies, and to use specialist help when needed.

2. Some better tools for assembly of intentions, analysis, and evaluation of FLDs should be developed by the CFS, based on GIS and other readily available systems. Databases of inventory information on all aspects should be assembled and made readily available.

3. A network of people across Canada and possibly further afield involved in different variations of FLD should be developed. This could be linked to the Model Forest Network and some seminars and/or conferences should be organized to focus on FLD as a means towards sustainable forest management.

4. A manual on designing sustainable forest landscapes describing the principles and practices and using a wide range of case studies should be produced. This is already underway, being written by Simon Bell and Dean Apostol with contributions from other people, including Nancy Diaz.

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